Technology Opportunity
Glenn Research Center • Cleveland • Ohio
Technology Transfer & Partnership Office
TOP3–00169

High-Performance Silicon Carbide (SiC) Fibers and Architectures

Technology

GRC has developed thermal treatment processes that have been shown to significantly improve the properties of preform architectures containing high-performance SiC fibers, such as the commercial Sylramic* SiC fiber.

Benefits

NASA's treatment technology has been shown to

- Significantly improve fiber creep-rupture resistance
- Form in-situ-grown boron nitride (BN) coatings on the fiber surfaces, which protect the fibers from oxidation and detrimental mechanical interaction
- Relieve stresses in a preform, which allows a preform to be permanently reshaped with effectively no loss in fiber tensile strength
- Provide treated preforms, which display superior thermostructural properties when compared to current high-temperature ceramic composites

Commercial Applications

The high-performance SiC fiber preforms treated using this NASA technology can be used to make high-temperature composites with high ultimate tensile strength, oxidative resistance, temperature capability, creep resistance, rupture life, and shape capability. These composites can be used in high-temperature structural components in aerospace, industrial, and military applications such as

- Engine hot-section components
- Heat exchangers
- Furnace components

Technology Description

Researchers at the NASA Glenn Research Center have developed treatment processes to improve the creep and rupture resistance of boron-containing high-strength SiC fibers, such as the commercial Sylramic fiber [ref. 1]. These types of fibers are often used to form architectural preforms that are used as reinforcement for high-temperature composite products. It has been shown that this treatment

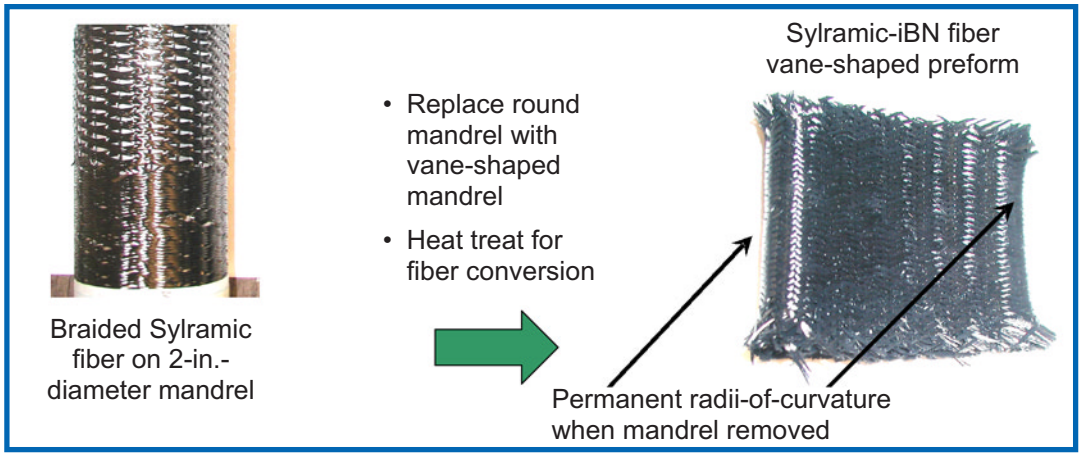

Figure 1.—For complex architectural preforms, GRC treatment simultaneously offers Sylramic fiber conversion, preform stress relaxation, and improved net-shape forming.

**Sylramic SiC fiber is currently being produced by ATK COI-Ceramics, Inc.*

technology, combined with the fiber coatings technology described in TOP3–00167 and the SiC Matrices technology described in TOP3–00168, allows the fabrication of state-of-the-art SiC/SiC composite panels [ref. 2].

NASA's process places an architectural preform, comprising thermally stable high-strength SiC fibers, into a furnace where it is processed in an atmosphere of controlled gas composition and pressure at temperatures up to 2000 °C. These architectural preforms can include one-dimensional continuous-length multifiber tows, individual or stacked two-dimensional fabric pieces, or three-dimensional structures net-shaped for specific composite products.

Table 1 compares the properties of Sylramic fibers processed using NASA's technology, referred to as Sylramic-iBN fibers, against those of currently available high-performance SiC fibers. The Sylramic-iBN fiber is overall superior to other SiC fiber types in terms of the key properties needed for reinforcement of high-temperature composites: tensile strength, creep resistance, rupture resistance at high temperatures, and thermal conductivity. As an additional benefit, NASA's process has been shown to relax residual stresses in sharply bent fibers, thereby allowing shape retention of sharp bends in the treated preforms. Figure 1 shows an example of how during treatment, architectural preforms can be simultaneously reshaped with minimal residual stress and with radii-of-curvature typically not obtainable in the original preform.

Options for Commercialization

There is a patent application in process for this technology. NASA is seeking companies interested in applying this technology to commercial applications.

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References

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Key Words

SiC fibers
Sylramic fibers
Architectural preforms
High-temperature composites

Type	Hi-Nicalon	Hi-Nicalon S	Tyranno SA	Sylramic	Sylramic-iBN
Strength (fabric), MPa	2100	1600	1300	2200	2100
Creep, 1400 °C, 250 MPa, 50 hr, air	>1.0%	0.2%	>0.5%	>0.5%	0.1%
Rupture temperature for 500 MPa, 1000 hr, air	1200 °C	1150 °C	1150 °C	1150 °C	1300 °C
Thermal conductivity, W/m °C	6	18	65	46	> 46

Table 1.—Key properties of high-performance SiC Fibers.

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